

Case reports

British Heart Journal, 1974, 36, 610-612.

Runaway pacemaker rhythm after 36 hours of electrical inactivity

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An 83-year-old male patient with third-degree atrioventricular (AV) block survived an episode of runaway pacemaker rhythm at a rate of 280 a minute with a 1:1 ventricular response. The implanted pacemaker generator exhibited the runaway rhythm 36 hours after complete electrical inactivity had been documented during the recording of a His bundle electrogram.

With the widespread application of permanent cardiac pacing, many publications have described bizarre manifestations of pacemaker failure including cases of life-threatening tachyarrhythmias induced by the pacemaker (Costeas *et al.*, 1965; Robinson *et al.*, 1965; Wisoff, Gabor, and Donoso, 1965; Wallace, Abelman, and Norman, 1970; Barold, 1973). The purpose of this communication is to report the emergence of a runaway pacemaker rhythm after unequivocal cessation of all pacemaker activity for a period of 36 hours.

Case report

An 83-year-old man had a permanent fixed rate pacemaker (Elema EM 152/70) implanted in June, 1970 for heart failure associated with third-degree atrioventricular block. Since then the patient had been followed in the pacemaker clinic (Mond *et al.*, 1972). In March 1973, a routine pacemaker check showed that the amplitude of the pacemaker generator artefact had decreased by 20 mV (6%) in lead II and the pulse width had increased by 1.2 msec in comparison to the measurements recorded one month before. There was no change however in the pacemaker rate of 68 a minute and there was 1:1 ventricular response (Fig. 1 panel A). As the patient's general condition was good, elective admission for replacement of the pacemaker generator was arranged and the patient sent home. Twenty-four hours later he experienced a typical Adams-Stokes attack and was brought back to hospital. An electrocardiogram showed complete heart block with an idioventricular rate of 36 a minute (Fig. 1 panel B). No pacemaker artefacts could be discerned.

A temporary transvenous pacing electrode was inserted

via the right femoral vein. A His bundle electrogram (Fig. 1 lower panel) just before the insertion of the temporary pacing electrode confirmed the absence of pacemaker artefacts.

While awaiting delivery of a new pacemaker generator the patient was observed in the coronary care unit and his electrocardiogram was monitored continuously and recorded on magnetic tape. A retrospective review of the tape showed that, suddenly, 36 hours after insertion of the temporary wire, the electrocardiogram revealed multiple small amplitude pacemaker artefacts occurring at a frequency of 280 a minute (Fig. 2 panel A). After an interval of 2 hours the amplitude of the pacemaker artefact increased and intermittent ventricular response occurred (Fig. 2 panel B). Dimorphic-paced QRS complexes were observed which were interpreted as competition between the temporary demand and the permanent implanted pacemaker. The rhythm rapidly changed over a period of 2 minutes to a 1:1 response to the implanted pacemaker artefact at a rate of 280 a minute (Fig. 2 panel C), and this pacing rhythm suppressed the temporary pacemaker which was set in the ventricular inhibited mode.

Despite the tachycardia of 280 a minute and an unrecordable blood pressure, the patient remained conscious and alert. In order to abort the runaway pacemaker rhythm the permanent electrode wire was cut close to the faulty generator. The runaway artefact ceased and temporary pacing was reinstituted from the external unit (Fig. 2 panel D). The blood pressure returned to 130/70 mmHg. The permanent pacing unit was replaced with an Elema EM 152 B 70 generator and the severed pacemaker electrode wire was reconnected. The patient was discharged 2 days later. The faulty replaced generator was sent to the manufacturer and subsequent analysis showed that the internal resistance

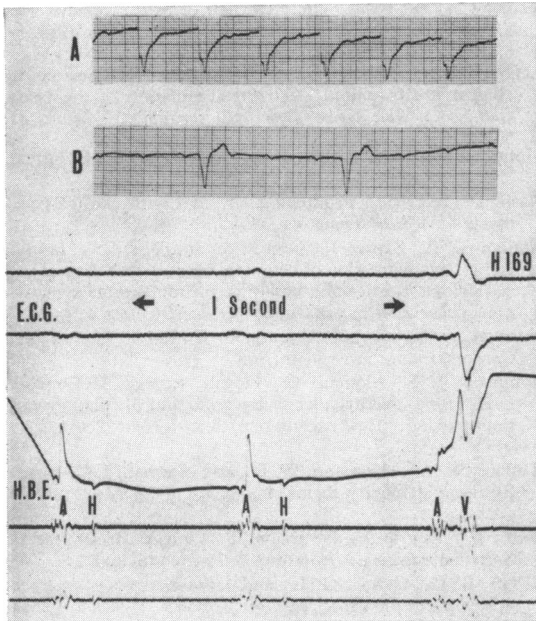


FIG. 1 A) Lead II showing 1:1 ventricular pacing to the permanent unit. B) Lead II showing 3rd-degree block with no evidence of a pacemaker artefact.

The His bundle electrogram records the patient in 3rd-degree heart block. No pacemaker artefacts are seen. H=His spike; A=atrial depolarization; V=ventricular depolarization.

of one of the mercury cells had risen to an abnormally high unstable value causing the runaway behaviour. When connected to a new set of batteries the electronics of the pacemaker had normal stable values. The manufacturers stated that all Elema pacemakers made after 1969 were modified, and since that modification they know of no further occurrence of this type of runaway phenomenon.

Discussion

Thirteen cases of runaway pacemaker rhythms exceeding a rate of 250 a minute have been reported (Gaal, Goldberg, and Linde, 1964; Kantrowitz, 1964; Nash, 1964; Nathan *et al.*, 1964; Aldridge and Kahn, 1965; Costeas *et al.*, 1965; Hoffman and Leight, 1965; Langendorf and Pick, 1965; Norman, 1965; Wisoff *et al.*, 1965; Welti, 1965; Hellerstein, Hornsten, and Ankeney, 1966; Wallace *et al.*, 1970). However, we were unable to find a record of a runaway situation occurring after complete cessation of electrical activity for a considerable time, shown by both a surface and an intracardiac electrogram. In the case reported by Aldridge and Khan (1965) there were transient periods of pacemaker inactivity lasting up to 40 seconds attributed to component

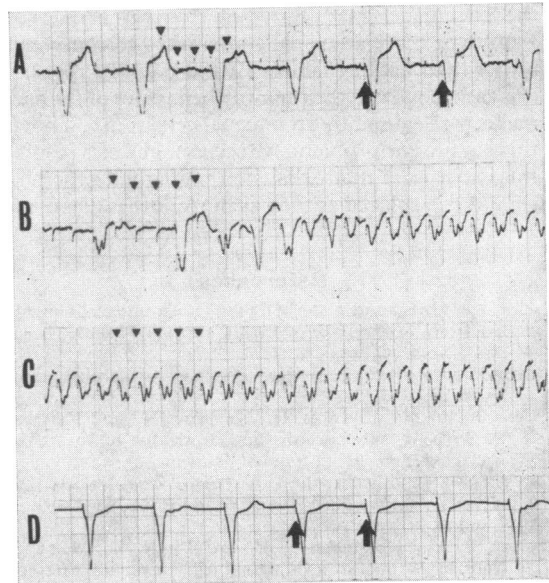


FIG. 2 A) Lead II showing the presence of multiple small pacemaker artefacts as indicated by the inverted arrow heads (\blacktriangledown). The upright arrows (\blacktriangle) show the ventricular response to the temporary pacemaker artefact. B) Lead II showing intermittent ventricular response to the permanent pacemaker artefacts. C) Lead II showing a 1:1 ventricular response to the pacing artefacts. D) Lead II after re-institution of pacing from the temporary unit.

failure, whereas in our case there was a period of 36 hours of documented complete electrical inactivity of the pacemaker.

Survival after a 1:1 ventricular response to a pacemaker artefact of 280 a minute as recorded in our patient appears to be a unique phenomenon. Usually the amplitude of the pacemaker impulse decreases as the rate increases, resulting in partial or complete loss of ventricular capture so that the patient may revert to his basic rhythm (Furman and Escher, 1970; Wallace *et al.*, 1970). However, in our case the amplitude was of a sufficient magnitude to produce a 1:1 ventricular response even at a rate of 280 a minute. Of the 13 cases reported of a runaway pacemaker rhythm of more than 250 a minute there were no instances of a 1:1 ventricular response. Of the 13 patients, 7 died as a result of the tachyarrhythmia. In 2 of the surviving patients there was complete cessation of ventricular pacing with reversion to an idioventricular rhythm.

In the event of battery exhaustion the pulse characteristics of the pacemaker vary with different models. Most units however exhibit some change in

the pacemaker rate. Rates in the region of 150 a minute or more are usually attributed to component rather than battery failure (Wallace *et al.*, 1970). In this case, however, the runaway behaviour of the pacemaker was caused by an unusual cell failure. Though this is a unique problem, we recommend as a result of this experience that exhausted implanted generators should be replaced as soon as the failure is diagnosed.

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